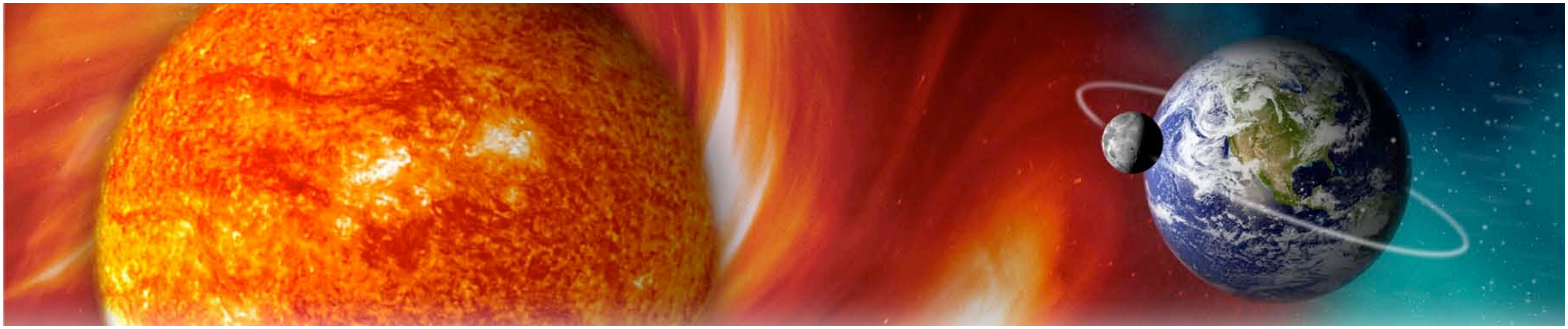


Town Hall Meeting

NASA Living with a Star Program Targeted Research and Technology Component

San Francisco Marriott

December 11, 2006

http://lws-trt.gsfc.nasa.gov

LWS TR&T Science Definition Team Report, November 2003

- LWS is a systematic, goal-oriented research program targeting those aspects of the Sun-Earth system that affect society.
- The TR&T component of LWS provides the theory, modeling, and data analysis necessary to enable an integrated, system-wide picture of Sun-Earth connection science with societal relevance.
- The successful implementation of TR&T depends on the adoption of the following principles:
  - Support data analysis and the development of theories and models that directly address TR&T priority targets, and that have potential societal benefits;
  - Require all TR&T-supported activities to identify deliverables with clear relevance to the program's goals and establish schedules and milestones for delivery;
  - Give particular emphasis to cross-disciplinary research;
  - Support synergistic activities such as workshops and summer schools to facilitate cross-disciplinary activities and to foster the development of a personnel infrastructure for Sun-Earth connection science;
  - Support the development of certain strategic capabilities that have broad potential use for science and application;
  - Support model testing and validation;
  - Support technology and data environment development relevant to LWS goals and objectives;
  - Support both small and large research proposals.

NASA LWS TR&T SC Charter

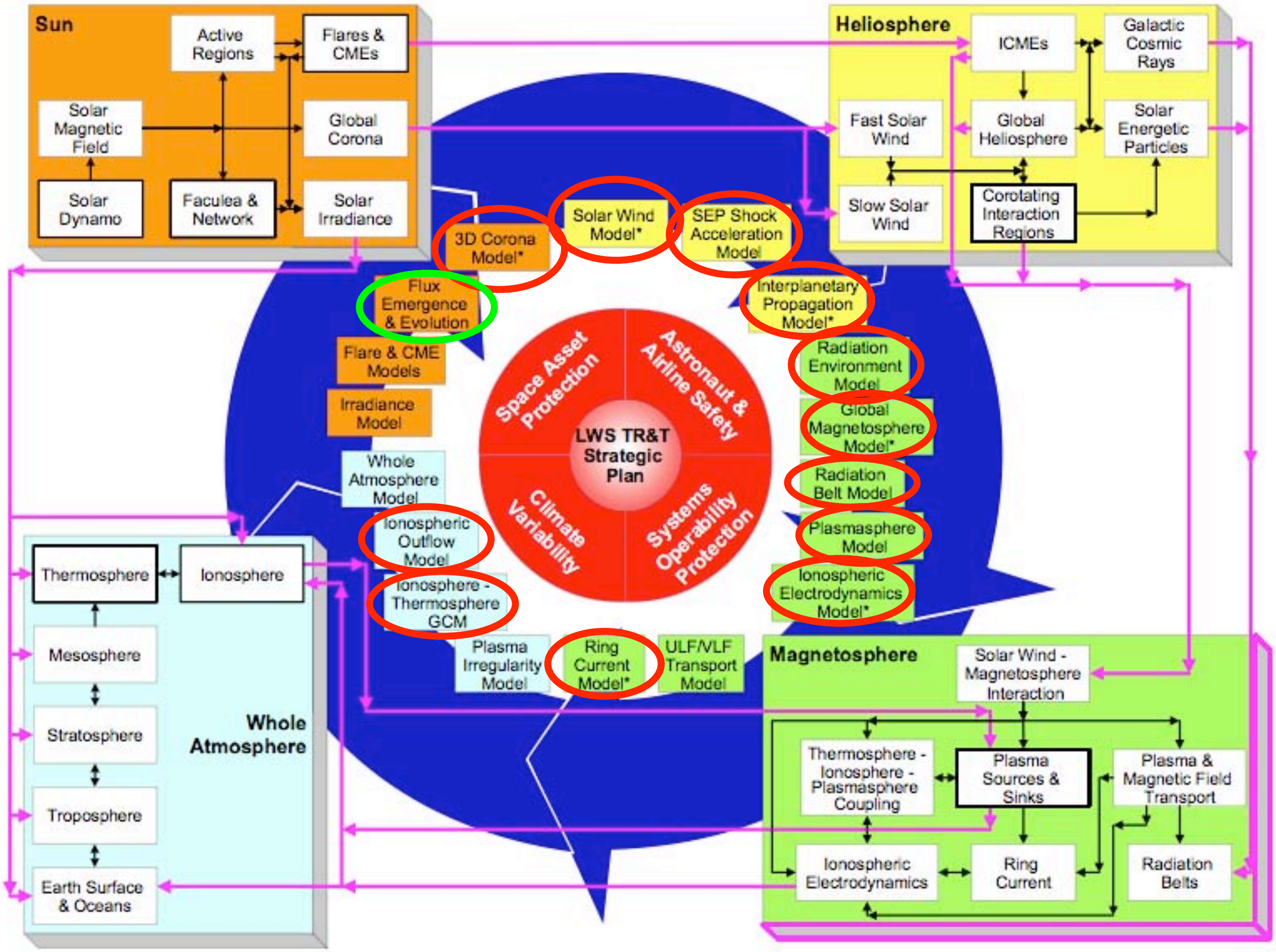
- A successful TR&T program must include four defining elements:
  - Periodically updated scientific targets.
  - Investigations that provide clearly-defined schedules and deliverables.
  - Cross-disciplinary research.
  - Large-scale projects that provide essential strategic capabilities for LWS.
- NASA HQ chartered the TR&T Steering Committee (TSC) to function as a top-level science working group for the LWS program, reporting to both the LWS Program Scientist and the LWS MOWG.
- The main role of the TSC is to examine the TR&T from an overall point of view to promote integrated Sun-Earth system science.
- The TSC is composed of solar-terrestrial scientists and representatives from the applications community. The members are selected on a rotating basis by the LWS Program Scientist.

- Update Scientific Targets
  - The TR&T, is required to produce science with a demonstrable impact on society:
    - It is a directed program with "targets" that are defined and updated on a regular and systematic basis.
    - The TSC determines the most important and timely scientific targets.
    - The TSC must ensure that no critical science "falls through the cracks."
- Define Strategic Capabilities
  - Both physics-based and empirical large-scale models must be developed. These models will also serve as community tools and as prototypes.
  - The TSC recommends strategic capabilities, their delivery sequencing, and the mechanism(s) for community access.
- Cross-Disciplinary Research.
  - The TR&T clearly requires research that crosses sub-discipline boundaries. The TSC will develop strategies for creating a community of cross-disciplinary researchers that is required for the success of LWS.
- Assessing Progress.
  - The TR&T is a program with targets and deliverables, therefore metrics and validation methods must be implemented to measure its success and to assess the societal benefits.
  - The TSC helps to develop metrics and validation methods to measure progress in the TR&T program. The TSC assists NASA HQ in using the results of these assessments to support and advocate the TR&T mission.

Overarching Goals of the LWS TR&T Component for the Next Decade

- Energetic particles from giant solar storms and galactic cosmic rays pose major radiation hazards for astronauts. Passengers and crew on polar flights are also endangered by penetrating particle radiation. In support of NASA's VSE objectives, the TR&T needs to deliver the understanding and modeling required for useful prediction of SEP variability and GCR modulation at the Earth, Moon, Mars and throughout the solar system.
- One of the major challenges facing humanity is global climate change. In order to determine effective mitigation policies, natural and anthropogenic causes must be distinguished; the TR&T needs to deliver the understanding of how variations in solar radiation and particles contribute to global and regional climate change.
- Communication, navigation and other national infrastructures are increasingly dependent on satellites orbiting Earth. With increasing miniaturization these systems are ever more sensitive to the near-Earth space environment. To protect these assets, the TR&T needs to deliver the understanding and modeling required for effective forecasting/specification of inner magnetospheric radiation and plasma.
- The upper atmosphere and ionosphere is central to a host of space weather effects, ranging from anomalous satellite drag, GPS position error, radio blackouts, radar clutter and geomagnetically induced currents (GIC). In order to mitigate space weather's impact on life and society the TR&T needs to deliver understanding and predictive models of upper atmospheric and ionospheric coupling above and below.

LWS TR&T Strategic Goal



NASA LWS TR&T SC Membership: 2006-07

Tamas Gombosi (Chair)	U. Michigan	global models
Phil Anderson	UT Dallas	ionosphere/thermosphere
Paul Bellaire	NSF ATM	sun/heliosphere & NSF
Doug Biesecker	NOAA SEC	user community
Reiner Friedel	LANL	magnetosphere
Jim Klimchuk	NRL	solar corona
Judith Lean	NRL	sun-climate
Tony Manucci	JPL	ionosphere/thermosphere
Peter MacNiece	CCMC	sun/global models
Bill Mattheus	U. Delaware	heliosphere
Merav Opher	George Mason U.	heliosphere
George Parks	UC Berkeley	magnetosphere
Mark Rust	U. Colorado	solar interior
Stan Solomon	NCAR HAO	ionosphere/thermosphere
Paul Song	U. Massachusetts	magnetosphere
Ray Walker	UCLA	magnetosphere/global models
Madhulika Guhathakurta	NASA HQ	LWS Program Scientist
Ramona Kessel	NASA HQ	LWS Deputy Program Scientist
Barbara Giles	NASA HQ	LWS Geospace Program Scientist
Donald Anderson	NASA HQ	LWS Earth Science Liason
Chris St. Cyr	GSFC	LWS Senior Project Scientist
Dave Sibeck	GSFC	LWS TR&T Project Scientist
Bill Wagner	NASA HQ	SDO Program Scientist
Jack Eddy	NSO	consultant

2007 Suggestions: Strategic Capabilities

- Solar spectral irradiance model
- Helioseismic imaging of emergence and evolution of active regions
- Predicting geo-effectiveness at Earth based on measurements near the Sun.
- Model for the near-Earth plasma-sheet environment
- Model (empirical and/or physics based) for causally driven ionospheric outflows
- Development of an integrated model of the atmosphere, thermosphere, and ionosphere

2003	2004	2005	2006
The magnetic field topology connecting the photosphere to the corona	Determine the solar origins of the plasma and magnetic flux observed in an ICME	Shock acceleration of SEPs by interplanetay CMEs	Predict emergence of solar active regions before they are visible
The propagation of the background solar wind flow and superimposed disturbances through the heliosphere	Determine the topology and evolution of the open magnetic field of the Sun connecting the photosphere through the corona to the heliosphere	Mechanism for solar wind heating and acceleration	Understand how flares accelerate particles near the Sun (i.e., through shocks and/or reconnection) and how they contribute to large SEP events
The generation and decay of the Earth's radiation belts as a function of geomagnetic and solar wind conditions	Relate solar-energetic particles to their origin at the sun and inner heliosphere	Solar wind plasma entry and transport in the magnetosphere	Effects of ionospheric-magnetospheric plasma redistribution on storms
The geophysical conditions favoring the development of low- and mid- latitude scintillations in the Earth's ionosphere	Determine the mechanisms responsible for the formation and loss of new radiation belts in the slot region in response to geo-effective solar wind structures	Storm effects on global electrodynamics and middle and low latitude ionosphere	Investigate the global distribution, sources and effects of large electron density gradients at middle and low latitudes
The effects of varying solar EUV radiation on the Earth's ionosphere and atmosphere	Quantify the response of thermospheric density and composition to solar and high latitude forcing	Atmospheric abundance of greenhouse gases and dynamics of the upper atmosphere	Solar origins of irradiance variations
The relationship between solar irradiance and cosmogenic proxies for long term solar activity	Quantify the sensitivity of regional and global climate to solar forcing in the full context of the interactive climate system		

Sun	Heliosphere	Magnetosphere	ITM	Sun-Climate
Determine the flows in the solar interior, and their effect on flux transport mechanisms and on predicting the solar cycle	Origin and evolution of the suprathermal seed population and its effects on large gradual SEP events	Location and rate of magnetic reconnection on Earth's magnetopause	Understand the strong storm-time response of the magnetosphere-ionosphere coupling at high latitudes	Regional responses of the climate and atmosphere to solar forcing
Bridging the gap between photospheric field measurements and the coronal models which use them	Propagation and spatial distribution of solar energetic particle events in the heliosphere	Given a solar energetic particle event, predict the distribution of these particles throughout the magnetosphere	Coupling and connections among the neutral and ionized thermospheric densities and winds, and responses to solar forcing	Mechanisms by which variations in solar spectral irradiance affect climate
Determine the conditions leading to CME/eruptive flare onset	Develop understanding of the factors that affect predictability of plasma and energetic particle energy transport between the solar surface and the Earth	Quantify the relative importance of different fundamental processes responsible for electron acceleration in the inner magnetosphere	Investigate persistent, significant modifications of the middle and low latitude thermosphere-ionosphere system during the recovery phase of intense geomagnetic storms	Investigate the processes (and associated uncertainties) by which ice-core records of various kinds indicate past variations in solar activity distinctly
Coronal Holes, Open Fields, and Solar Wind Sources	Global understanding of the GCR modulation and propagation in the heliosphere and their effect on space weather	Quantification of the competition between acceleration and loss of relativistic electrons in the radiation belts	Investigate the sources, effects, and variability of thermospheric winds	Responses of natural variability modes within the Earth's atmosphere to solar forcing
	Develop the capability to simulate transients on global heliospheric scales to understand and predict the short and long-term variability of GCRs	High fidelity self-consistent models and the experimental derivation of dynamic, global magnetic and electric fields in the inner magnetosphere	Comparative assessment of terrestrial responses to photon-driven vs. particle/plasma driven solar energy input changes	
	Physical processes in the formation and evolution of shocks in the solar wind from Sun to Earth	Cross-scale inner magnetosphere coupling		
	Propagation of CME/transients through the heliosphere including space weather aspects	Quantifying the effects of radial diffusion and wave particle interactions on radiation belt particles		
	Determine and model the solar wind microphysical processes needed for input to global models of space weather	Source and loss processes responsible for the plasma distributions in the near-Earth plasma sheet		
		Vertical coupling among regions of the sun-earth system, and responses to solar forcing		
	Understanding solar wind preconditioning upstream of the magnetopause and its impact on magnetospheric dynamics			
	Self-consistent modeling of wave growth and their effects			

- Lika's challenge: "In this round of Steering Committee selection, I would very much like to see focus topic that are **truly cross-disciplinary** in nature. For example.....forming a topic that will utilize solar radiation observations with effects on ionosphere/thermosphere in preparation for SDO, CNOFS, SWARM and AIM launches. Similarly, solar wind observations at 1 AU and effects on magnetosphere/radiation belt....utilizing ACE, WIND observations in preparation for RBSP launch. These are just examples but illustrates the cross-disciplinary aspect I am looking for."
- We have a long way to go before we can meet Lika's challenge. The present list of potential focus topics is far too disciplinary.
- We will evaluate the present focus groups and define "success."
- We need serious discussion about metrics, validation and "how we define success."
- Most important: please send comments, suggestions, criticism to **tamas@umich.edu**